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ZhMSI [Zhurnal obshchey biologii, epidemiologii i immunologii -- Journal of Microbiology, Epidemiology, and Immunology], No 8, 1952, contained a discussion on certain questions of the theory of general epidemiology for the purpose of meeting the remaining practical requirements of public health in this science. In connection with this it appears to us to be of great current importance to consider the question of the sources and live carriers of the causal agents of infectious diseases, since the practice of anti-epidemic work in diseases with natural foci requires clearcut concepts about these questions.

Thus Gromashevskiy writes in his guide to general microbiology that "exact knowledge of the source of infections correctly and immediately orients all our practical measures indicating a rational arrangement of the individual links of anti-epidemic work" (page 36 [of publication indicated]). He noted that a principled formulation of the answer to this question is rarely encountered. And indeed authors often confuse this concept, understanding instead various objects which serve as material substrates for the transfer of the causal agent. In order to convince oneself of the accuracy of this postulate, it is enough to adduce an extract from Osnovy epidemiologii [Fundamentals of Epidemiology] by Stallibras who on page 271 wrote that "the hide, hair, and other products of animals which have died from anthrax are sources of the human infection, and spores may exist in them for a long time."

However these elementary sources are not at present the subjects of our evaluation.

As the teaching of Ye. N. Pavlovskiy on natural focuses of transmissible diseases of man Zhurnal obshchey biologii [Journal of General Biology], Vol 7, No 1, 1940, becomes more and more assimilated by many physicians and as we recognize more and more the complex relationships which occur in certain diseases between causal agents, live carriers, and the host of the causal agent, it becomes not so easy to have a clearcut opinion about sources of infection.

Let us attempt to estimate the essential limitations of this concept. Gromashevskiy believes that "as a source (or initial source) of infection must be understood that object which serves as a site of natural existence and multiplication of causal agents in which the process of natural accumulation of the origin of infection occurs and from which the causal can infect healthy persons by one means or another" (ibid., page 36). Gromashevskiy emphasizes that the infective origin source must be strictly

distinguished from the carrier. Also he points out that bloodsucking arthropods -- ectoparasites of animals -- can be the carriers of the causal agent from animals to man in a number of infectious diseases.

According to Pavlovskiy the existence of natural centers of transmissible diseases of man is secured by the fact that the causal agent of the disease circulates from the animal-donor through the carrier to the organism of the animal-recipient which in its turn becomes the donor of the causal agent. In the natural focuses there can be a heterogeneity of species of animals which are sources of the causal agent and consequently hosts of the focus. By the term "host" Pavlovskiy understands "that creature whose organism is the permanent or temporary habitat of the parasite, at the same time serving as the source of its nutrition" (Uchebnik parazitologii cheloveka [Textbook of Human Parasitology], 1951, page 7).

Thus, comparing the formulations presented above, the definite conclusion can be drawn that the hosts in natural focuses of transmissible diseases are the sources of the causal agents.

However, free use of these terms may be found in Gromashevskiy, who in the chapter on factors of transmission (pages 85 and 93) writes that live carriers in the majority of cases "are the biological hosts of the causal agents of infectious diseases." Or he attributes to the live carriers the role of an additional source of the causal agent. For example, "the causal agents of many 'tick' infections are transmitted to the tick descendants by the germinative route. This makes the ticks very refractory as carriers of the appropriate infections, which enable us to regard them as accessory (to rodents) sources (reservoirs) of infection." Pavlovskiy on the other hand understands as the biological host, as follows from his teaching on natural focuses, specifically the organism of the donor (recipient).

By the way, it should be mentioned that it is hardly expedient to identify the concept of the source of an infection with the reservoir of origin of the infection. Certainly, the reservoir may be regarded not only as a repository of the causal agent, but also in a carrier sense -- as an abundant source of it. However -- considering that in epidemiology quite frequently only the site of maintenance of the causal agent is understood by the term reservoir -- the use of this word in any other interpretation should inevitably lead to confusion in the concepts. Thus in the literature the application of this word to live carriers is often encountered, which is a number of cases are persistent maintainers of certain causal agents of disease. Let us return to Pavlovskiy, who in his Rukovodstvo po parazitologii cheloveka [Guide to Human Parasitology], 1948, page 590, writes the following. "Ultimate observations in a focus have shown that adult ticks, thanks to their capacities of existing for a long time in the inactive state, can, by concealing themselves in the surface layers of the soil, serve under natural conditions as reservoirs of very long duration of the causal agent of tularemia -- up to 3 years, and possibly more."

Microbes -- the causal agents of a number of diseases, especially of those which are connected with natural focalizations (plague, tularemia, etc) -- have in the process of their evolution adapted themselves to alternating existences in the host organism and in the organism of the live carrier. Therefore both the host organism and the organism of carriers should be regarded as sites of habitation of the causal agents of these diseases. And even though the conditions of life are different for the causal agent in each one of them, the role of repository (reservoir), which

to suggest by the use of the carrier, still cannot be placed at the basis of an opinion on the "source" of the infection. Therefore the use of the term "carrier" in the sense of source or carrier of infection about it is completely unacceptable.

By the way, it is also unacceptable to substitute the word, "carrier" or "maintainer" for the concept of source or host of the causal agent. For example, in the work "The Plague Disease in the USSR as an Ecological Problem" (Zoologicheskii zhurnal, epizootologiya i parazitologiya) [Moscow, 1954, Vol. 1, No. 1, page 10] on rodents as the sources of the causal agent of plague calls them "plague carriers." In Zoologicheskii zhurnal (Moscow, Zoology) XXXIII, No. 4, page 1263) calls them "maintainers." This author writes that the problem of the "rodent types" or rodents is intimately connected with "the organization of the work on the annihilation of maintainers and carriers of infection." Certainly, in this case by the term "maintainers" he meant rodents, a possible source of the causal agent.

Indeed the terms which we are analyzing reflect, so to speak, only the longevity of the causal agent in the organism of its sources and say nothing about the mass reproduction of the microbe. It is known that in many transmissible diseases the live carriers are carriers and maintainers of the causal agent a longer time than are their sources.

The terms "maintainer" and "carrier" arose, apparently, back in those times when there was an attempt to explain the endemicity of plague only by the possibility of maintenance of the causal agent during the inter-epidemic period in the organisms of hibernating rodents -- turkogens, susliks, and jerboas (Klodnitskiy).

Passing to the examination of the role which the biological host and carrier play as the sources of nutrition and multiplication of the causal agent, it should be mentioned that here there is undoubtedly sufficient basis for distinguishing between them. The different life of the causal agent which takes place in the organisms of the host and of the carrier as media of habitation can serve as a proper basis for this.

Subdividing live carriers into groups according to the nature of the interrelationships with the causal agents transmitted by them, Pavlovskiy (Zoologicheskii zhurnal, Vol XXVI, No 4, page 297) points out that even with mechanical transfer by inoculation or contamination of the recipient by the feces of the carrier, there occurs in the gastrointestinal tract of the latter a multiplication of the causal agent (for example, causal agents of plague in the organism of the flea, the causal agent of typhoid in the organism of the house fly). Multiplication of the causal agent in the organism of the carrier occurs all the more with specific forms of transfer such as propagative or cyclopropagative transfer.

Yet the intensity of multiplication of the causal agents in the organism of the carriers, even under the most favorable conditions, for it, is never realized with such a vigor with which it exists in the organism of the ecological host during the period of the manifest form of the course of the infectious process.

Actually Lyenko (report to the session of the All-Union Academy of Agricultural Sciences, 1949, page 25), in developing the theory of

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vitality and defining this concept, noted that the vitality of the organism is defined by the intensity of the vital process. "The greater the necessity with which a living body enters into unity with the conditions of life and the greater necessity with which it assimilates certain conditions of the environment, the more vital is the given body, the more intense is its vital process."

For such causal agents of disease as the bacteria of plague, tularemia, and others, the vitality is different in the organism of susceptible animals from that in the organism of live carriers as media of habitation. The intensity with which the capacity for life is realized in the organism of susceptible rodents is very great. At the time of the septicemic phase of the infectious process the bacteria usually deluge the sick organism; this leads to the agonal septicemia from which the causal agent may pass into the organism of a bloodsucker. Consequently the relationships which are created between the animal --- the donor, as a medium of habitation and the organism --- the causal agent of disease in many illnesses for the well-defined phase of the infectious process express the greatest necessity for the microbe to assimilate the conditions of life, in connection with which there also occurs its mass reproduction. And this is one of the conditions which determine the continuity of the existence of the causal agent of disease as a definite vital form.

In the organism of carriers the causal agent of disease never finds those conditions which can lead it to such a mass reproduction. This is understandable because in the process of historical evolution live carriers of transmissible diseases have in nature fulfilled the functions of transfer, which has also been one of the conditions of maintaining the causal agent as a species.

In connection with this it should also be mentioned that the source of an infection basically does not put into effect a mechanism of transfer of the causal agents of disease, particularly not of transmissible diseases, whereas live carriers, in fulfilling this role, complete the chain of circulation of the causal agent in the epizootic (epidemic) process.

This certainly is far from signifying that the historical development of diseases went only along this route. It is known that the maintenance of the causal agent as a species in rabies is connected with its direct transfer by donors to the organism-recipient.

However despite this the differences which lie at the basis of our concepts on sources of infections and live carriers of infection according to their functions in the epizootic (epidemic) process and according to the role which they play as media of habitation for the causal agents of diseases are adequate to enable us to form definite opinion on each of them.

To standardize the terminology applied in connection with sources and live carriers of transmissible diseases, it becomes all the more requisite that the roles on the primary and of the secondary sources be quite distinct in the sustenance of the natural focalization of transmissible diseases.

As is known, Pavlovskiy divides centers of transmissible diseases according to the species variety of the sources of the causal agent into monohostal and polyhostal. Ingeniously developing this part of the teaching, Penyuk believes it necessary to emphasize that of the great

number of causal agent sources detected not all of them play a similar role in the focalization. They are quite clearly divisible into primary and secondary. Focalization of the disease is connected with the first, whereas the secondary ones play no role in the maintenance of the focus, although sometimes they have great epidemiological significance. Whence also the relationship of the epidemiologists to each of them will be different and dependent on the problems posed.

Thus, evaluating the question of the sources of the causal agent and of the live carriers of them, it appears to us, that they should be divisible into 3 functions which these components of the peizootic (epidemic) process accomplish.

The first of them is connected with possible dwelling of the causal agents of transmissible diseases which occurs in the organism of the hosts and to a still greater degree in the organism of the carriers. In connection with this each of them becomes a repository or reservoir of the causal agent for a definite period. Since they both accomplish this function to a similar degree, it cannot serve as a criterion for deciding about sources and live carriers of the causal agent. Therefore there is no basis for identifying the reservoir concept of infection with either one or the other component of the process under analysis.

The second function is connected with the roles which they play in mass multiplication of the causal agents of disease. In this sense the host organism as a medium of habitation accomplishes the function of providing sustenance and by this is converted into the source of the causal agent. The live carrier, in whose organism most often there are no proper conditions for intense development of the vital processes of the causal agent, does not accomplish this function to such a degree.

Thus the source of the infection is the organism of the biological host in which the population of the causal agent can increase up to very wide limits, securing under certain conditions its striking the organism of a live carrier of the infection.

Finally the third function is connected with the transfer of the causal agent of the disease. In the group of infectious diseases analyzed, the mechanism of transfer usually secures a live carrier of the causal agent.

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